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IGNIS FATUUS

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AMONG the meteoric appearances which have puzzled man ever since he began to inquire into the relations of phenomena and which are still unexplainable is the *ignis fatuus*, *jack-o'-lantern* or *will-o'-the-wisp* as it has been variously called. Reference to this peculiar manifestation was much more frequent in the writings of one hundred years ago than it is at the present time and many people have come to think of it as a purely imaginary phenomenon, belonging in the same class with witches and fairies with which it is so frequently associated in literature. While there are, no doubt, many fanciful and highly colored accounts of this puzzling phenomenon, there are also many well-authenticated records of its observance by men thoroughly competent to pass upon its reality. There is, however, considerable divergence in the accounts of different observers, and it does not seem improbable that unfamiliar lights of different kinds have been classed under the same name.

Most observers speak of the *ignis fatuus* as a flame. Thus Benjamin Martin, in his "Philosophical Grammar," published in 1758, says:

Ignis Fatuus, i. e., the foolish Fire or Jack in a Lanthorn, when a fat unctuous vapour is kindled and wafted about by the motions of the Air, near the Surface of the Earth, like a Light in a Lanthorn,

and most definitions since that time seem to have followed this one as a pattern. However, Newton had long before distinguished between this light and a true flame. In the third book of his "Opticks" Newton propounds the following query:

The *Ignis Fatuus* is a Vapour shining without heat, and is there not the same difference between this Vapour and a Flame, as between rotten Wood shining without heat and burning Coals of Fire?

In 1728, Mr. Derham, who had undertaken a special study of *ignis fatui*, laid before the Royal Society a letter from Dr. Giacomo Beccari, of Bologna, to whom he had written for information concerning these mysterious appearances. Beccari says, in part:

What I am going to offer you, concerning these fiery appearances, is the result of several conversations I had upon this subject with several

experienced travellers, men of learning and reputation, whose sincerity I had no reason to mistrust. For my own farther satisfaction, ever since I received your commands, I have made it my business to speak with as many as I could light of, with such as travelled much in the mountains, and with others that observed them in plains, on purpose to see whether or no the difference of the place made any sensible difference in the appearance. I find upon the whole that they are pretty common in all the territory of *Bologna*. To begin with the plains, they are very frequently observed there; the country people call them *Cularsi*, probably from some fancied resemblance to those birds; and because they look upon them as birds, the belly and other parts of which are resplendent like our shining flies. They are most frequent in watery and morassy grounds; and there are some such places, where one may be almost sure of seeing them every night, if it be dark. In the fields near the bridge *Della Calcarata*, in a common, belonging to the parish of *S. Maria in dono*, north of *Bologna*, one of these fiery appearances is very often observed to move across the fields, coming from another bridge, called *Della fossa quadra*. There is another of them in the fields of *Bagnara*, almost east of *Bologna*, which scarce ever fails to appear in dark nights; particularly when it rains or snows; as also in cold and frosty weather: Both these, I mean that near the bridge of *Calcarata*, and that in the fields of *Bagnara*, are very large; and I am assured that sometimes their light is equal to that of one of our ordinary faggots, or bundles made of vine-branches; and that it is scarce ever less than that of the links which our country people make of hemp stalks, and which they light themselves withal, when they travel in the night. That at *Bagnara* appeared, not long since, to a Gentleman of my acquaintance, as he was travelling that way; it kept him company for a mile or better, constantly moving before him, and casting a stronger light on the road, than the link he had with him.

I believe there may be several more in other plains, as large as these two; tho' at present I have not been able to get certain information of any others. Lesser ones there appear a good many; some of them giving as much light, as a lighted torch; and some are no bigger than the flame of a common candle. Of these I have been assured a good many have been observed in the fields of *Barisella*. All of them have the same property, in resembling, both in colour and light, a flame strong enough to reflect a lustre upon neighboring objects all round. They are continually in motion; but this motion is various and uncertain. Sometimes they disappear of a sudden, and appear again in an instant in some other place. Commonly they keep hovering about six foot from the ground. As they differ in largeness, so do they in figure, spreading sometimes pretty wide, and then again contracting themselves. Sometimes breaking to all appearances into two, and a very little while after uniting again into one body; sometimes floating like waves, and letting drop some parts, like sparks out of a fire. I have been assured that there is no dark night all the year round, in which they do not appear. And in the very middle of winter, when the weather is very cold, and the ground covered with snow, they are observed more frequently than in the hottest summer. The Gentleman, who gave me an account of that at *Bagnara*, told me, that if I had a mind to see it myself, I might be sure of finding it, if I went thither in very cold weather; and in a sharp frost. Nor doth either rain nor snow in any wise prevent or hinder their appearance; On the contrary,

they are more frequently observed, and cast a stronger light in rainy and wet weather. This last circumstance, it is true, has been taken notice of by some writers, and among the rest, if I remember right, by the learned *Gassendus*. Nor does the wind much hurt them; tho' one should think, that if it were a burning substance, like common fire; it should either be dissipated in windy weather, or extinguished by rain. But since they do not receive any damage from wet weather; and since, on the other hand, it hath never been observed, that anything was thereby set on fire; tho' they must needs in their moving too and fro, meet with a good many combustible substances; it may thence be very reasonably inferred, that they have some resemblance to that sort of phosphorus, which doth, indeed, shine in the dark; but doth not burn anything, as common fire doth:

* * * * *

As to the appearance of this phenomenon in mountainous parts, by what I have hitherto been able to learn, they differ in nothing else but in largeness; and all those I conversed with, that saw them in the mountains, agree that they never observed any larger than the flame of an ordinary candle. Nor do those that live in the mountains call them *cularsi*, which name is, perhaps, us'd only by the country people in the plains for those large ones above described. The difference of the air, and that of the soil, may, for ought I know, contribute a great deal towards the different sizes of these appearances; at least all I can offer material at present towards solving this particular circumstance, namely with regard to their largeness, is, that those grounds where we observe the largest fires, as at *Bagnara*, are what they here call *strong ground* (*terreni forti*) being a hard, chalky and claiey soil, which will harbour the water a long while, and is afterwards, in hot wether, very apt to break into large cracks and fissures: Whereas on the contrary, those soils in the mountains, where they observe the small fires, are what they call soft, or *sweet ground* (*terreni dolci*) being generally sandy, and of a more loose contexture, which do not keep the water so long as the others. Of that sort also is the soil in the above mentioned plains of *Barisella*, where about 7 or 8 years before, they observed a good many of the smallest *ignes fatui* in the fields within the compass of about 3 miles.

The above excerpts from Beccari's letter probably give the best second-hand information available at that time to one who was interested in science and who lived in a region noted for the frequency of the phenomena under consideration. They seem to show that there were at that time regions where these luminous appearances were of frequent occurrence and of large size. They seem to show also that the people who were familiar with them recognized a difference between them and a true flame.

Alexander von Humboldt also calls attention to this distinction. He says that in Cumana, Venezuela, flames are frequently seen at night which are visible at a great distance, but which do not set fire to the dry grass. In most cases, at least, they seem to give off neither heat nor odor.

The one recorded observation which the present writer has

been able to find in which the observer claims to have shown that this light was a real flame is quoted in *Poggendorff's Annalen* from the Italian *Annali di fisica*, etc., of 1841. The article is in the form of a notice from Dr. Quirico Barilli Filopanti, of Bologna. Filopanti begins by referring to a statement which was made to him by the painter, Onofro Zanotti that while passing along a street a fiery ball with the appearance of a flame rose from between the stones of the street near his feet, passed so near him that he could feel the heat on his face, and then very quickly disappeared. Filopanti became greatly interested in the narration and determined to try to see one of these lights for himself. He accordingly spent many evenings watching for the phenomenon, especially in the neighborhood of church yards, which he was informed were favorable places for seeing them. He says that his vigils were rewarded by the sight of three. Of these he says:

The first was one of those which come out of the earth, rise to a certain height and then suddenly disappear. I can say little more of this than that it rose rapidly to a height of three or four meters and then disappeared with a faint report.

The second was carried by the wind horizontally, and was followed by me for some distance, when it was carried over the water of the Idice and then disappeared.

The third gave Filopanti an opportunity to test whether it was a real flame. He states that after watching for several evenings in a place said to be favorable to the appearance of these lights, at a place where hemp was being rotted in a small brook near a church, he went into a peasant's house one evening to take shelter from the rain, which was falling. While watching from a window, he saw the wished-for light, and seizing a long rod with some tow on the end, which he had prepared for the occasion, he ran out and approached the light. He described it as a smoky flame, about a decimeter in diameter, which was moving slowly from south to north. As he approached it, it began to rise, but he was able to thrust his tow into it and see it ignite. Very soon afterward the light went out. He says that the burning tow gave a faint odor which was not like phosphorus, but which seemed to him to be of a sulphurous character with some odor of ammonia.

In Volume 41 of *Poggendorff's Annalen* is a notice taken from *Comptes Rendus* which says:

On Sunday, Dec. 22, 1839, between five and nine o'clock in the evening, by mild and rainy weather, phosphorescent flames were seen to rise from slimy pools in the streets of Fontainebleau. These flames, when they rose from the water gave off a "crépitation" and wherever they were seen the

air was permeated with a strong odor of phosphorus. When the water from which the flames rose was stirred, it became phosphorescent.

This appearance, though classed under the head of *ignis fatuus*, was apparently quite a different phenomenon from those generally observed, as was the flame described by Filopanti.

A quite different description of an observation of these strange lights is given by the astronomer Bessel in a letter to the editor of *Poggendorff's Annalen* which was probably called out by the above notice. Bessel describes the observations which he made from a skiff on a small stream which flowed through a peat marsh as follows:

These appearances were observed by me on Dec. 2, 1807, early in the morning, on a very dark and calm night during which, from time to time, a gentle rain fell. They consisted of numerous little flames which appeared over ground which was covered in many places with standing water and which after they had glowed for a time disappeared. The color of these flames was somewhat bluish, similar to the flame of the impure hydrogen which is prepared by the action of dilute sulphuric acid on iron. Their luminosity must have been insignificant, since I could not observe that the ground under one of them was illuminated nor that the great numbers of them which frequently appeared at the same time produced a noticeable brightness. A closer estimate of their brightness I can not make, since the darkness of the night made my estimates of the distances of the flames very uncertain. Some of them, which seemed brighter than others, were estimated to be not more than fifteen or twenty steps distant, but this estimate is necessarily insecure.

As regards the number of flames which were visible at one time and as regards the period of their burning I can not speak with certainty, since both conditions were quite variable. I can only estimate as some hundreds the number visible at a time, and a quarter of a minute as the average period of their luminosity.

The flames frequently remained quiet in one position, and at other times they moved about horizontally. When motion occurred, numerous groups of the flames seemed to move together. I remember that one of the groups of flames suggested the moving of flocks of water birds.

Bessel describes the place where these observations were made as over a peat bog along a small brook. Much of the bog was covered with pits from which peat had been taken out, and pools of water stood in these depressions. It was over these pools that the lights appeared. He says that the boatman who was with him in the skiff, and who frequently carried peat through this marsh in the night, did not regard the appearance as at all unusual.

A similar observation to Bessel's was reported to the meteorologist Dove by *Schulrath* Loeff, of Gotha. The observations in question were made by a student for whom Loeff vouches. This student, Theodor List, was walking by night on a road

along the valley of the Fulda. The observation was described by List in part as follows:

The valley of the Fulda was covered by a heavy white fog, and a strong moldy smelling vapor filled the air. Suddenly, I saw a little flame scarcely two steps from me at the side of the road. I thought I must be deceived, but the moon was shining brightly and I was broad awake. To satisfy myself, I started toward the light, but when scarcely a foot distant it disappeared. But not a second had passed until I saw another, then a second, three, four, others. All the little flames remained quiet in one place and neither leaped nor danced. I observed that if the lights were not to disappear I must approach them very quietly, taking care not to set the air about them in motion. When I was very careful, I was often so fortunate as to bend over the little flames and observe their color and form at a distance of not more than a foot and a half. They were little flames of the size of a hen's egg, and they stood very quietly between the blades of grass. They were mostly of a greenish white light, and were fairly bright. I was able to seize some of them in my hand, but no heat was to be detected. If I waved a finger near them they disappeared at once. Many of them disappeared with a faint report, such as is made by the ignition of a bubble of phosphuretted hydrogen. Still, I must say that the air remained perfectly quiet.

A single flame seldom lasted longer than a minute and a half. The moon shone so brightly that I was able to read the dial of my watch. I could not have been deceived, for I observed the phenomenon very carefully and accurately. My eyes were completely clear, for I observed other objects about me and saw no lights between me and them.

A similar observation was reported by Galle as having been made by one of his students, Herr Vogel, of Leipzig. Vogel reports having seen *Irrlichter* twice, once along the marshy shores of a pond near Kamenz, and later just outside of Leipzig. The latter observations were made over a tract of marshy ground which received the drainage from some of the streets of the city, and through which a cut had recently been made by the Leipzig-Dresden Railway. The lights were seen in this railway cut. Vogel says:

After waiting for some time, I saw a faint light in the railway cut and observed a little flame about as bright as the vapor which is given off by a gently rubbed phosphorus match and very similar to this. This little flame disappeared very quickly, and after perhaps three seconds appeared again in the same place, and disappeared as before. I observed the phenomenon from a very close distance for several minutes without observing any odor. Likewise, I saw no smoke. The ditch was not filled with water, but its bottom was slimy. The little flames glowed about three inches above this slimy bottom, and were perhaps an inch high. The appearance was exactly similar to that which I had observed at Kamenz, only in that case the lights were much more numerous, so that it gave the appearance of the moon shining on rippling water.

Vogel states that the flames did not resemble those of spontaneously igniting phosphine, or of burning marsh gas.

A very different appearing *ignis fatuus* is described by Knorr, professor of physics at Kieff, as having been seen by him while a student at Berlin. Knorr describes two observations of these lights in his childhood, both of which correspond to the descriptions given by Bessel and List. The third seems to have been of quite a different character. This one, Knorr observed by the roadside at night where a bridge crossed a swampy stream. The light appeared in the grass over the marsh, and less than a foot beyond his reach when he lay on the ground. On account of the swampy nature of the bottom he feared to step into the marsh, but he lay near the light and observed it for a long time, passing his walking stick through it, and finally holding its ferule in the flame for fifteen minutes without it becoming appreciably warmed. He describes the light as of cylindrical form, perhaps five inches high and one and a half inches in diameter, standing quietly among the leaves of the marsh grass. He saw no smoke and observed no odor and the leaves of plants which were in the cylinder of light showed no signs of combustion. He describes the light as being bright enough to bring out plainly the surrounding foliage, though the night was very dark. The light did not seem to be easily disturbed by the movements of the air near it, and persisted until Knorr went on his way and left it.

Numerous other accounts of the appearance of these strange lights are probably familiar to the readers of this article, and many of them are, no doubt, of a fanciful character. Before the extensive draining of marshes over the earth, when these lights were more numerous than at the present time, they were regarded with superstitious fear by many of the people who most frequently saw them, and their accounts of them are, no doubt, frequently colored by this fear. One form of this superstition is shown in the name "corpse candle," which was applied to these lights in some localities.

Apparently different kinds of lights have been observed at different times. Certainly, the smoky flame described by Filopanti was quite different from the little clouds of luminous vapor described by Bessel, List, Vogel and Knorr. The present writer, when a child, was told by his father of lights which the latter had seen over a peaty pond in Ohio, and his description was similar to that given by Bessel, except that the observed lights were very few in number.

These little vaporous clouds seem to possess none of the characteristics of a flame of any kind. They are frequently spoken of as some kind of an electrical glow, and for the same

reason that many other phenomena which we can not explain are guessed to be electrical in their nature. However, the conditions under which these lights are seen are as far as possible from any under which an electrical glow is known to exist.

To the present writer, there seems but one probable explanation of these obscure phenomena, and that is that they are little swarms of luminous bacteria which are carried up from the bottom of the marsh by rising bubbles of gas. Many kinds of luminous bacteria are known and the marshes from which these lights arise are known to be the favored habitat of some of these kinds. Some, at least, of these bacteria do not become luminous until exposed to the oxygen of the air. This seems to be true of the bacteria which cause the luminosity of rotten wood, the "fox fire" of our boyhood.

In Volume 2 of *Nicholson's Journal* is described a rather extensive series of experiments by Nathaniel Hulme on luminous wood, fish, etc., in various gases. Hulme found that only air or gases from which oxygen could be derived would support the luminosity. It could be completely quenched in hydrogen, but after several hours immersion in this gas it would appear again if exposed to air or oxygen. Certain it is that bubbles of marsh gas and carbon dioxide gas are almost continuously rising from peaty marshes. The former, being lighter than air would carry its colony of bacteria rapidly upward until they were dissipated by diffusion. The latter, being heavier than air, would remain for sometime near the surface of the water, and would diffuse into the air much more slowly. Whatever would set up a circulation in the water would tend to dislodge these gas bubbles with their charges of bacteria from the bottom. Was not Newton probably right in his suggestion that there is "the same difference between this Vapour and Flame as between rotten wood shining without heat and burning Coals of Fire"?